ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation	)	ET Docket No. 93-62

COMMENTS OF FORD MOTOR COMPANY

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SUMMARY

Ford Motor Company ("Ford") hereby comments on the Commission's proposal to amend its National Environmental Policy Act regulations to reflect the revised 1992 guidelines of the IEEE and ANSI for exposure to radio frequency fields. The proposal might also expand the group of entities that are required to conform to the guidelines in order to avoid detailed environmental assessments. Ford agrees that the Commission must ensure its rules reflect an up-to-date scientific consensus and that the agency's communications regulatory actions must protect the public health. Use of the 1992 revision in FCC regulations that reference the ANSI/IEEE standard would serve these objectives, and Ford supports its adoption by the Commission.

Nevertheless, before the agency can require compliance with the new policies, licensees and other entities that will be obliged to meet the new standard must know with particularity how to comply with the rules. This, in turn, will require clarification from the Commission on two issues of particular concern to the automotive industry.

First, as the IEEE itself acknowledges, further clarification is needed on techniques for measuring electric and magnetic fields within 20 cm of any object. Measurements degrade when probes are placed near antennas or re-radiating structures, and the inside of an automobile has many such areas. At present, an IEEE subcommittee is reviewing this problem, and Ford suggests that the agency await the

IEEE's response before requiring verification of compliance with the ANSI/IEEE standards in areas closer than 20 cm from an object.

Under the standard as drafted, the sole method for determining compliance with the guidelines for areas within 20 cm is through calculation of specific absorption rates ("SARs"). However, as the IEEE and ANSI stress, measuring SARs is "a challenging task." At present, there are few devices in the marketplace that would permit actual assessment of SARs, and it is unclear whether such devices are reliable or can produce repeatable results. Moreover, researchers are only now developing mathematical models and formulas that could be used in design and to simplify compliance assessment. Until the Commission adopts standards for measurement technology and compliance methodology, it would be virtually impossible to demonstrate compliance with the new guidelines.

As a result, Ford recommends that the Commission first establish the procedures necessary for assessing compliance with the new ANSI/IEEE guidelines. These might include specifying physical models for making actual measurements of field exposure within 20 cm of an object and measurements of SARs. The procedures also should include mathematical formulas, charts or other methods for assessing compliance with SAR requirements through relation to E-field measurements. Such procedures could be established with the cooperation of industry and other experts as the FCC revises the compliance procedures contained in its OST Bulletin 65, a process in which Ford would be pleased to participate.

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The Ford Motor Company ("Ford") hereby comments on the Commission's proposal[1] to update the regulations governing evaluation of radiofrequency ("RF") radiation environmental effects from FCC-regulated equipment, regulations now based on the 1982 American National Standards Institute ("ANSI") exposure standards. Although Ford supports the FCC's proposed eventual reliance on the 1992 edition of the ANSI standard,[2] the transition process should reflect ANSI's finding that "no verified reports exist of injury to human beings or of adverse effects on the health of human beings who have been exposed to electromagnetic fields within the limits of frequency and SAR specified by previous ANSI standards."[3]

In this context, Ford recommends that, prior to implementing the new regulations, the FCC clarify aspects of the new standard regarding measurement of RF

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[1] *See* Environmental Effects of RF Radiation, 8 F.C.C. Rcd 2849 (1993) ("*NPRM*"). The comment date was extended by order of the Office of Engineering and Technology. *See* Environmental Effects of Radiofrequency Radiation, DA 94-34 (Jan. 10, 1994).

[2] *See* ANSI 95.1-1992, Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (previously issued by IEEE and IEEE (95.1-1991)) ("1992 ANSI Standard"). This standard would replace the previous document C95.1-1982, upon which the Commission has relied for several years.

[3] 1992 ANSI Standard, § 6.

fields close to other objects, such as within an automobile. Specifically, the FCC should address a number of practical issues through revision to it compliance guidelines -- now contained in OST Bulletin 65 -- before requiring adherence to the new policies.

I. INTRODUCTION

Ford is one of the world's largest manufacturers of automobiles and related components. Its participation in the instant proceeding derives from the fact that certain automobiles manufactured by Ford are, or will be, equipped with optional radiating devices regulated by the Commission, including mobile cellular telephone transceivers. Ford is vitally interested in the health and safety of consumers using such equipment, and intends to incorporate the 1992 ANSI standard into its automobile design guidelines given sufficient progress on measurement procedures.

Ford acknowledges the important work involved in updating and refining the 1982 ANSI standard. Ford supports that the conservative safety factors adopted and the many conservative assumptions incorporated into the new ANSI standard for radio frequency radiation exposure intended to ensure a large margin of safety for the public. Accordingly, Ford believes that the public interest will be served by the Commission's ultimate adoption of the exposure limits of the 1992 ANSI guidelines.

Nonetheless, it must be remembered that the FCC's plan is to incorporate the new standard into the rules (just as the 1982 version is today[4]) and to require applicants for FCC licensing and authorization to demonstrate compliance with the

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[4] *See* 47 C.F.R. § 1.1307(b) (1992).

document in order to avoid detailed environmental assessment.[5] Thus, the Commission contemplates adopting the ANSI/IEEE work as a substantive rule, conformance with which would be required. Due process requires that affected parties be able to understand, and predict, what type of systems will be found to meet the new standards and what will not, in order for them to be able to design equipment that qualifies.

Unfortunately, the new ANSI/IEEE standard itself fails to provide this level of certainty. This does not necessarily reflect any deficiency on the part of the IEEE/ANSI effort, but rather that the standard was designed as a voluntary guideline describing a scientific consensus as to acceptable exposure levels. Adaptation of that guideline to a particular industrial application was not attempted by IEEE or ANSI, but instead left to the parties that chose to employ the standard.

The Commission's proposal to implement the new RF field standard and expand compliance responsibilities to substantially more entities than under the present rules gives rise to a need for the agency to address these implementation gaps. As yet, the Commission has not identified or approved either particular measurement techniques or charts, formula and tables, such as those now contained in OST Bulletin 65 for broadcasters, that permit demonstrating compliance without complicated field measurements. Before the new guidelines can be enforced, the Commission should -- in cooperation with industry and others -- standardize such measurement techniques,

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[5] Indeed, the Commission is proposing to delete several existing categorical exemptions from demonstrating compliance, such as the current exclusion of Part 22 equipment from that portion of the rules. *See* 47 C.F.R. § 1.1307(b) note 1.

and provide simplified procedures that permit, in appropriate cases, assessing compliance without field measurements.

Moreover, as those involved in developing the standard expressly acknowledge, substantial scientific measurement issues remain to be clarified, particularly about measurement of RF fields "within 20 cm of any object" and the determination of specific absorption rates (SARs). As described below, the ANSI/IEEE document provides few specifics about such close-in evaluation, much less a standard modeling or estimating technique for making measurements and correlating them with possible biological effects. These unresolved matters are of critical importance to Ford, and other automobile manufacturers, because much of the space in an automobile is within 20 cm of some object. Accordingly, further clarification is required from ANSI, the IEEE or other sources before all of the new version of C95.1 properly can be given regulatory force by the FCC.[6]

II. THE COMMISSION SHOULD REQUIRE DEVELOPMENT OF A UNIFORM MODELING TECHNIQUE FOR DETERMINATION OF COMPLIANCE IN SPACES WITHIN 20 CM OF OBJECTS

A. The Commission Must Clarify How Measurements May Be Made Within 20 cm Of Objects

The new standard provides adequate guidance for electric and magnetic field measurements taken more than 20 cm from any object. Compliance with the standard in those regions may be demonstrated by electric field measurements made with

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[6] A copy of these comments is simultaneously being forwarded to the Secretary of the IEEE Standards Board and to ANSI as well.

standard test equipment.[7] Thereafter, measurement results can be compared with the simple tables contained in Sections 4.1.1 and 4.1.2 of C95.1, which provide specific values for the proposed maximum permissible exposure (MPE) in each frequency range.

Considerably more complicated approaches apparently are necessary to measure compliance with the new standards in areas within 20 cm of any object, including within 20 cm of antennas and other radiating objects. Because of complex measurement anomalies in those areas, the ANSI/IEEE standard states that "it is not possible to predict the [exposure levels] . . . using only the measured external field strength."[8] It recognizes that measurements near the active radiator are often in error:

> The accuracy of measured data can be affected when using a near-field probe to map large spatial gradients very close to radiating elements of an RF emitter (an antenna or a leakage source). These gradients may cause the amplitude of the field to vary significantly over the volume of space that is occupied by the probe antennas, thereby introducing measurement error due to spatial averaging.[9]

Moreover, even at some distance from the radiating source, "[w]hen measurements are made with a hazard probe placed close to conducting or high-dielectric-constant objects

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[7] *See* 1992 ANSI Standard, § 4.3(3); ANSI C95.3-1992, IEEE Recommended Practice for the Measurements of Potentially Hazardous Electromagnetic Fields--RF and Microwave at § 1.3 ("C95.3-1992 ANSI Measurement Techniques").

[8] C95.3-1992 ANSI Measurement Techniques, § 3.2.7.

[9] C95.3-1992 ANSI Measurement Techniques, § 5.3.6.2.

(scatterers or 'passive reradiators'), large errors may result,"[10] which could occur near any automobile surface containing metal (*e.g.*, roof, instrument panel, floor). Indeed, the ANSI/IEEE document expressly notes "automobile steering wheels" in a list of such passive reradiators.[11]

Given the geometry of vehicles, many locations within the interior of an automobile are within 20 cm of an object, *i.e.*, the roof, floor, seats, windows, etc. Yet, it is far from clear how exposure limits in those areas are to be measured. IEEE comments in this proceeding confirm that further explanation will be required to permit such measurements, and that a Subcommittee is examining the issue to "clarify the intent of the standard with respect to such exposure."[12] This measurement techniques gap presents particular difficulties for automobile manufacturers and their cellular telephone providers which, for the most part, have never before been required to demonstrate compliance with RF rules[13] and consequently may not be experienced in applying established measurement procedures.

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[10] *Id.*, § 5.3.6.

[11] *Id.*, § 5.6.2.1.

[12] Comments of the IEEE-United States Activities Committee on Man and Radiation, ET Docket No. 93–62 at 2 (filed Nov. 10, 1993) [hereinafter IEEE COMAR].

[13] *See* Biological Effects of Radiofrequency Radiation, 2 F.C.C. Rcd 2064, *erratum*, 2 F.C.C. Rcd 2526, 2533-34 (1987). The current rules exempt most of the land mobile communications products installed in automobiles from RF radiation standards.

Ford submits that these scientific measurement issues must be resolved before compliance can be mandated.[14] Consistent with any IEEE clarification of its standard, the Commission should formulate clear and precise measurement procedures, similar to those now contained in OST Bulletin 65. Ford commits to providing the FCC automobile-related information to assist the agency in developing these procedures.

B. The Commission Must Clarify How SAR Measurements Are To Be Made

If demonstrating compliance with the MPE remains impossible over large areas because they are too close to other objects, regulations encompassing standards in C95.1 may require entities to show that specific absorption rates (SARs) are within the listed values (expressed in Watts per kilogram) in Sections 4.2.1 and 4.2.2 for whole body average and peak exposure levels. Again, the IEEE is now examining "whether all such exposures require determination of specific absorption rates."[15] Ford anticipates that there may be instances where MPE field measurements, or simpler surrogates not requiring measurements, can provide adequate assurance of compliance

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[14] This approach would parallel the process described by the Commission at the time the original regulations were adopted in 1985:

> In order to address these various concerns related to the determination of compliance with standards, and to give guidance to our licensees, we plan to issue a technical bulletin which will be developed by Commission staff before the effective date of our rule amendment. This bulletin will discuss prediction methodology, evaluation of exposure situations, measurement problems, multiple source siting, and other relevant issues.

Amendment of Part I, 100 F.C.C.2d 543, 555 (1985).

[15] IEEE COMAR at 2.

and recommends that the Commission not limit its approach until the IEEE has addressed this issue.

If SAR data is required in some cases, as the *NPRM* appears to suggest,[16] the complications multiply. Unfortunately, as ANSI and IEEE acknowledge, determination of SARs still is far from an exact science. SAR measurements essentially require modeling -- either physical modeling or mathematical modeling -- of the human body and the effects of radiation thereon. This is quite complex and not fully understood: "The determination of this SAR requires either internal field measurements in the tissue . . . or a thermographic method, neither of which is currently practical for humans, or the measurement of induced tissue-currents that may be related to local SARs through knowledge of tissue geometries and electrical parameters."[17] Today, such theoretically acceptable techniques still are fraught with practical difficulties, as the ANSI measurement standard document recounts:

- The measurement of SAR in exposed biological subjects at radio frequencies is a challenging task.[18]
- The local SAR values and the SAR distribution in biological objects cannot be measured without producing relatively large measurement uncertainties, regardless of the instrumentation used.[19]

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[16] The *NPRM* asks whether such measurements should be required to be submitted to the Commission. *NPRM*, 8 F.C.C. Rcd at 2851.

[17] 1992 ANSI Standards, § 6.6.

[18] C95.3-1992 ANSI Measurement Techniques, § 3.2.5.

[19] *Id.*, § 3.2.6.

- It is difficult to obtain repeatable results at a location of a large spatial SAR gradient.[20]

- Significant errors can occur when SAR is measured, using temperature probes, at a single point in an object with one or more "hot spots" near, but not coincident with the probe tip.[21]

- The relationship between the spatial maximum field strength and the SAR is very complex, varying considerably as the orientation and spatial distribution of the fields change with respect to the exposed object.[22]

- SAR measurements with implantable E-field probes have several inherent sources of error associated with them.[23]

- [T]hermodynamic factors and the imprecise knowledge of the value of the specific heat capacity of the tissue or phantom material tend to limit the accuracy and precision of SAR measurements made via thermography.[24]

Recognizing these problems, the *NPRM* properly asks for information on "measuring electric and magnetic fields, induced body currents, and contact currents."[25]

Various attempts have been made at developing physical modeling exposure levels inside human tissue.[26] However, as noted above, these are subject to wide

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[20] *Id.*, § 5.5.1.

[21] *Id.*

[22] *Id.*, § 5.6.1.

[23] *Id.*, *app. C*, § C1.

[24] *Id.*, *app. C*, § C2.

[25] *NPRM*, 8 F.C.C. Rcd at 2854.

[26] *See, e.g.*, Stuchly, Specific Absorption Rate Distribution in a Heterogeneous Model of the Human Body at Radiofrequencies, Report PB87-201356, Ottawa University (1987); Chaterjee, Gandhi & Hagmann, Numerical and Experimental Results for Near Field Electromagnetic Absorption in Man, IEEE Transactions on Microwave Theory and Techniques, vol. MTT-30, no. 11 at 2000-05 (Nov. 1982); Guy, Analyses of Electromagnetic Fields Induced in Biological Tissues by Thermographic Studies on

(continued...)

variation and considerable uncertainty. No one physical model has been developed that works under all conditions, and the ones that do exist are cumbersome, requiring, for example, the creation of simulated tissue gel inside mannequins, which then necessitates using a bactericide and refrigeration to preserve the gel and maintain its close analogy with human fat, muscle, brain and bone.[27] Given the required level of complexity, the process is unlikely to produce repeatable results.

Experts are also working on the creation of solely mathematical models to predict SAR exposure. Such models have the enormous advantage of relying on E-field measurement input, making it possible to determine compliance with commercially available (to-be-developed) test equipment that yields valid and repeatable measurement data.[28] Ford is not aware, however, that any single mathematical model has proven acceptable in all situations, much less one that is commonly available and simple to use.

Absent refinement of these techniques, showing compliance with the requirements of the proposed rule would be difficult if not impossible even for equipment whose emissions were within the standard. Moreover, because there are

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[26](...continued)
Equivalent Phantom Models, IEEE Transactions on Microwave Theory and Techniques, vol. MTT-19, no. 2 at 205-214 (1971).

[27] C95.3-1992 ANSI Measurement Techniques, app. C, § C4.

[28] Guy & Choi, Impact of the RF Radiation Controversy on Cellular Mobile Telecommunications Systems, Proceedings, International Congress on Transportation Electronics (Oct 1984) (IEEE Cat No. 84CH1988-5), *cited in* Amendment of Part 1, 100 F.C.C.2d at 573 n.15 (Further Notice of Proposed Rulemaking); Belzano, Garay & Steel, Energy Deposition in Simulated Human Operators of 800-MHz Portable Transmitters, IEEE Transactions on Vehicular Technology, vol. VT-27, no. 4, at 174-81 (Nov. 1978).

numerous different models for SAR measurements, results from different tests may not be consistent. Entities before the FCC could not feasibly establish that their equipment complied with the rules, and the Commission would be hard-pressed to confirm such compliance.[29] Due process, the Administrative Procedure Act, and the maintenance of public confidence all require that such ambiguities be resolved prior to adopting this part of the standard.

Ford has developed no proprietary procedure for accurate SAR modeling -- physical or mathematical -- for automobile environments and is not aware of any suitable standard techniques used elsewhere within the automotive community. However, similar techniques were codified in OST Bulletin 65 for broadcast stations. These licensees are given the ability to refer to simple charts, tables and formulas containing "safe harbor" limits for demonstrating compliance without field measurements.[30] Ford believes that -- given the difficulties of SAR modeling -- a similar approach for SARs is justified here.

Ford recommends that the Commission, in cooperation with industry and with the guidance of ANSI and IEEE, develop specific recommended modeling techniques for SAR measurements, particularly simpler and more accurate mathematical models. This effort could mature as the Commission, industry and others together seek to revise the OST 65 compliance manual to specify particular procedures for determining SAR

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[29] *See* Comments From Matsushita Communication Industrial Corp. [MCC/Panasonic], ET Docket No. 93-62, at 10 (filed Nov. 12, 1993).

[30] Evaluating Compliance with Fee-Specified Guidelines for Human Exposure to Radiofrequency Radiation, OST Bulletin No. 65 at 2 (Oct. 1985).

exposures.[31] After validating such models, a process in which Ford would be pleased to participate, the Commission can be assured of receiving useful and comparable information while giving the industry sufficient guidance.[32]

III. CONCLUSION

Before requiring compliance with the proposed ANSI/IEEE limits for measurements within 20 cm of an object, Ford respectfully submits that the FCC should secure clarification of the 1992 ANSI/IEEE on the specifics of MPE

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[31] Ford also notes that Section 4.4 of the 1992 ANSI standard, which deals with relaxation of power density limits for partial body exposures, states that compliance with the recommended levels are determined from spatial averages of power density or field strength "over an area equivalent to the vertical cross-section of the human body (projected area)." 1992 ANSI Standard, § 4.4. In an automobile, the human body is crouched in a seated position, rather than fully extended. Ford is concerned that averaging over a vertical cross section could produce measurement results at variance with actual radiation exposure. The IEEE and ANSI should clarify the proper technique to be used when measuring exposure of humans in a seated position.

[32] When the Commission selects appropriate techniques for SAR modeling, industries subject to the new standards may need additional time for implementation of testing procedures before the rules become effective.

measurements within 20 cm of an object. Moreover, the Commission should work with industry and the IEEE to identify appropriate SAR measurement techniques, including mathematical compliance models that simplify the compliance process. Ford is prepared to assist the Commission in this effort, which can probably be accomplished in the necessary revision of the agency's compliance bulletin. Resolution of the acknowledged measurement concerns common to many entities, and clearly prevalent in the automobile environment, will permit the Commission to ensure both that users of mobile cellular telephones in automobiles enjoy the full protection of the new guidelines, while confirming that licensed and other entities can reliably determine compliance with the new rules.

Respectfully submitted,

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